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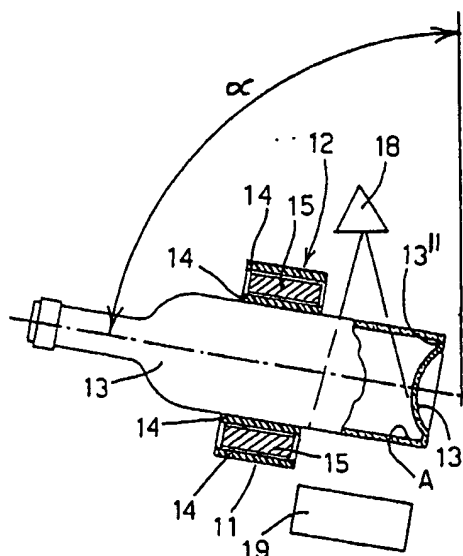
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(54) Title: APPARATUS FOR NON-DESTRUCTIVE INSPECTION OF CYLINDRICAL CONTAINERS FOR LIQUID PRODUCTS



(57) Abstract: Apparatus for non-destructive X-ray inspection of cylindrical containers (13) for liquid products, comprising means (10) for transferring said cylindrical containers along a substantially rectilinear direction, whereby said containers (13) are made to take an inclined position about the advance direction when said containers (13) are being conveyed through the X-ray unit.

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## APPARATUS FOR NON-DESTRUCTIVE INSPECTION OF CYLINDRICAL CONTAINERS FOR LIQUID PRODUCTS

The present invention relates to an apparatus for non-  
5 destructive inspection of cylindrical containers for liquid products.

More particularly, the invention concerns an apparatus for X-ray inspection of cylindrical containers, such as glass bottles and vessels for liquid foodstuffs such as wines and other drinks.

It is known that non-destructive X-ray inspection of  
10 containers for liquid products is carried out by stationary inspection apparatuses within which the containers to be inspected are conveyed on a conveyor belt with horizontal plane. Such apparatuses comprise suitable X-ray generators/detectors and the relevant control circuitry.

15 Inspection of foodstuffs containers is intended to detect the presence of possible contaminants within the container. Indeed, it is possible that during processing and bottling a particle or fragment of an alien substance, generally of higher specific weight than the liquid in which by chance it is present, becomes  
20 introduced inside the container.

Since glass bottles are concerned, such an alien substance might be a glass fragment detached from the container edge, for instance during the corking step.

It is also known that cylindrical containers such as glass  
25 bottles for drinks often have an inward curved bottom defining an annular zone with closely spaced side walls, difficult to be inspected by X-ray units. Any glass fragment or other object with higher specific weight than the liquid will become deposited by gravity onto said annulus at the bottle bottom.

30 Different solutions to the problem of how to detect the presence of said fragments in a container with an inward curved

bottom have been proposed in the past.

A first solution is disclosed in Italian Patent No. IT 1291498 in the name of the same applicant.

According to the teaching of said Italian patent an X-ray  
5 inspection apparatus comprises a vertically developing device for transferring the containers or bottles, which device is arranged to upset the containers about an axis perpendicular to the advance direction, on a plane parallel to the advance direction.

The above device is provided with two half-circular curved  
10 sections separated by a rectilinear section along which the X-ray unit is located. The first curved section of the device performs the bottle rotation by 180°, so as to present them in upset condition through the X-ray unit, whereas the second curved section brings again the bottles to the upright position.

15 Thus, contaminants falling down by gravity toward the bottle cork while the bottle is being upset can be inspected without any interference due to the shape of the bottle bottom.

A drawback of the device of the above patent is that the bottle is to be upset in order to be inspected, and this is time consuming.

20 In other prior art devices, the bottles are shaken so that contaminants deposited on the bottom become suspended and their presence can be detected.

Also this method however is slow and inaccurate, and it cannot be used in connection with drinks for which shaking is not  
25 convenient.

Therefore it is an object of the present invention to remedy the above drawbacks, by providing an apparatus for the quick and secure inspection of glass containers having a curved bottom.

The above and other objects are achieved by the present  
30 invention, which concerns an apparatus for the non-destructive X-ray inspection of containers for liquid products, such as glass

vessels or bottles, as claimed in the appended claims.

The apparatus according to the invention comprises means for transferring the containers through the X-ray unit and arranged to bring the containers to an inclined position about the advance  
5 direction when said containers are being conveyed through said X-ray unit, while keeping a substantially rectilinear and horizontal advance direction.

Advantageously, the containers are inclined about the advance direction by an angle which is a function of the shape of  
10 their curved bottom and of the difference of specific weight between contaminants and the liquid being contained, so as to achieve a quick displacement of the contaminants towards a region more readily accessible by the X-ray unit, with a minimum inclination of the containers.

15 The known chain conveyors can be used as means for transferring the containers in inclined position through the X-ray unit.

An example of chain conveyor is disclosed in PCT patent application WO 99/15443 by FLEXLINK SYSTEMS AB. The chain  
20 conveyor according to the teaching of said PCT application comprises a chain of articulately interconnected plane link members running on suitable guides.

The invention will now be described with reference to the accompanying drawings, relating to a preferred but not limiting  
25 embodiment thereof, and in which:

- Fig. 1 is a schematical side view of an inspection apparatus according to the invention;
- Fig. 2 is a plan view of the inspection apparatus shown in Fig. 1;
- Fig. 3 is a perspective view of the inspection apparatus shown in  
30 Fig. 1;
- Fig. 4a is a schematical view showing the position of a bottle

when entering the apparatus;

- Fig. 4b is a schematical view showing the position taken by a bottle in the inspection apparatus during inspection.

With reference to Figs. 1 to 3, inspection apparatus 1  
5 according to the invention comprises a plurality of supports 2 on which there is mounted a linear conveyor 10 consisting of two facing chain conveyors 11, 12 with vertical plane. Thanks to the two chain conveyors, cylindrical containers 13 are conveyed in a rectilinear direction, parallel to ground.

10 Said cylindrical containers 13 may be for instance, glass bottles having a bottom 13' curved towards the bottle inside and defining an annular region 13" where contaminants, if any, present within bottle 13 become deposited.

In the preferred embodiment of the invention, four supports 2  
15 are provided, two of which support the end portions of conveyor 10 while the other two support the central portion of conveyor 10. If however the conveyor length makes it necessary, the conveyor can be supported by a greater number of supports.

Each of the two chain conveyors 11, 12 comprises a chain 14,  
20 consisting of a plurality of articulately interconnected plane links, made of a material suitable for laterally holding glass bottles 13 during conveyance. Each chain conveyor 11, 12 is driven by a driving unit 16 including a motor reducer.

At both ends of conveyor 10, chain conveyors 11, 12 are each  
25 arranged with vertical plane so as to take and release bottles 13 in upright position.

Between the two intermediate supports of conveyor 10, a central portion 10' is provided where chain conveyors 11, 12 follow a twisted path so as to take an inclined position while remaining  
30 parallel with each other, the conveyors resuming the vertical position while following the inverse path.

In this respect, central supports 2 are so constructed as to allow supporting chain conveyors 11, 12 located at different heights.

During said twisted path, bottles 13 pass from the upright position to the inclined position.

Advantageously, the X-ray unit, comprising at least one emitter 18 and at least one detector 19 for inspection of the contents of bottles 13, is located in correspondence with the twisted conveyor portion in order to inspect the bottles while in inclined position.

Contaminants, if any, deposited on the annular bottom 13" of bottles 13 are thus displaced by gravity towards region A that is more readily accessible by the X-ray unit.

With reference to Figs. 4a and 4b, a guide 15 keeping separate the two runs of chain 14 is schematically shown for each chain conveyor 11 and 12.

With reference to Fig. 4b, emitter 18 and detector 19 of the X-ray unit are arranged in dependence of the inclination taken by bottles 13, so as to emit radiation in the direction entailing minimum interference by the glass bottom and walls of bottles 13.

In the exemplary embodiment shown in Fig. 4b, bottle 13 is inclined for inspection by an angle  $\alpha$  of about  $80^\circ$ . Preferably, according to the invention, the inclination to be given to the bottle will be in the range  $90^\circ \pm 10^\circ$ ; yet, by exploiting the same inventive principle, conveyor capable of conferring an inclination by an angle in the range  $0^\circ$  to  $180^\circ$  can be provided.

If an upset of bottles 13 is desired, the twisted paths of chain conveyors 11, 12 will entail upsetting the running plane thereof by an angle of  $180^\circ$  and, consequently, the exchange of the mutual positions of chain conveyors 11, 12.

The inclination to be given to bottles 13 is predetermined

depending on the shape of bottom 13' thereof and the specific weight difference between the contaminant and the liquid in the bottle, so as to obtain a quick displacement of contaminants from annular region 13" to region A by giving the bottles an inclination  
5 as small as possible.

Of course the positions of emitter 18 and detector 19 could be modified depending on the inclination given to the bottles, so as to inspect a bottle region, other than region A, where contaminants, if any, will become deposited depending on the inclination.

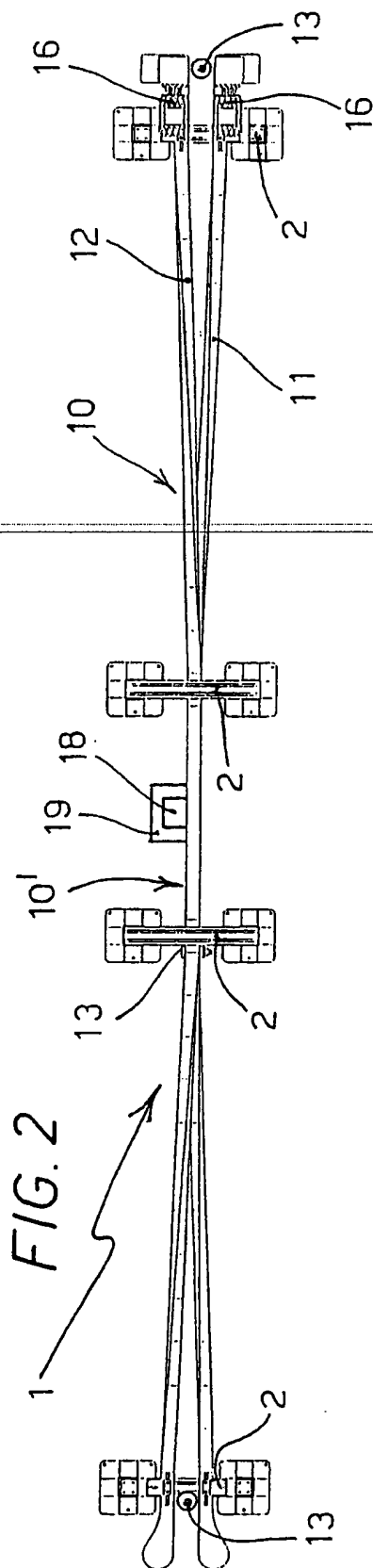
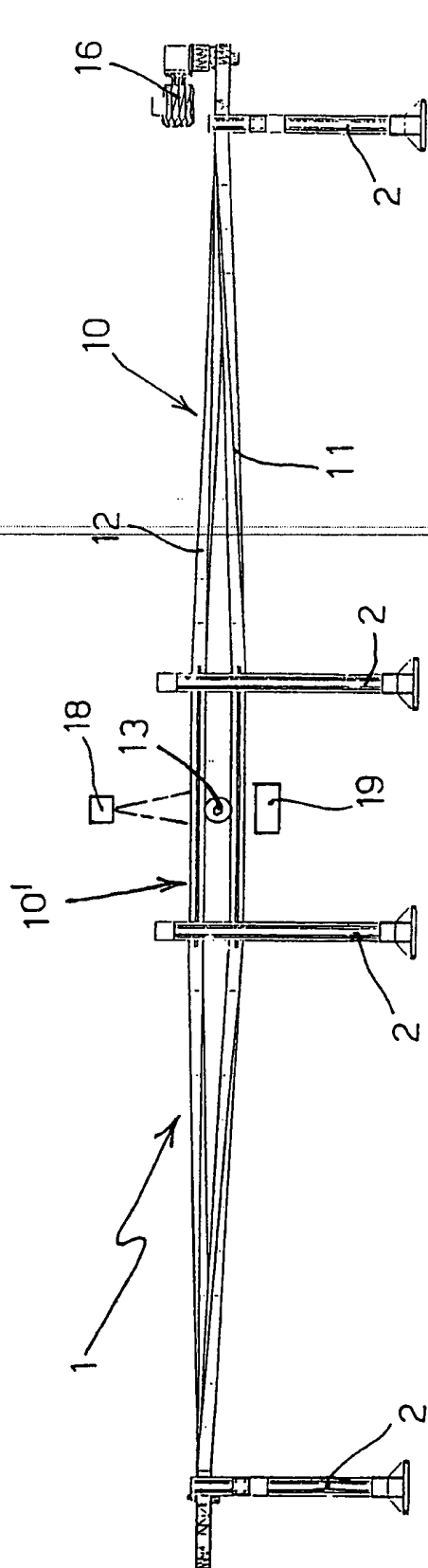
**Patent claims**

1. Apparatus for non-destructive X-ray inspection of cylindrical containers (13) for liquid products, comprising means (10) for transferring said cylindrical containers (13) along a substantially rectilinear direction through an X-ray unit,  
5 characterised in that said means (10) are arranged to make said containers (13) take a position inclined about the advance direction when said containers (13) are being conveyed through said X-ray unit.
- 10 2. Apparatus for non-destructive inspection according to claim 1,  

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characterised in that said transferring means (10) comprise a pair of chain conveyors (11, 12) travelling parallel to each other along a twisted path such that the containers (13) held between said conveyors take a position inclined by an angle in the range  
15 0° to 180°.
3. Apparatus for non-destructive inspection according to claim 2, characterised in that said angle is an angle of  $90^\circ \pm 10^\circ$ .
4. Apparatus for non-destructive inspection according to any preceding claim, characterised in that said X-ray unit has at  
20 least one emitter (18) and at least one detector (19), so arranged relative to the containers (13) that at least the portion of said containers is inspected where contaminants, if any, present in the containers (13) become deposited due to gravity and the inclination taken by the containers (13).





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